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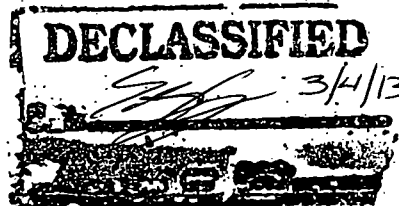
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June 8, 1979



IN THE MATTER OF PUBLIC HEARING ON  
BOKUM RESOURCES CORPORATION  
PROPOSED DISCHARGE PLAN, DP-43

SUMMARY STATEMENT, RECOMMENDATIONS AND PROPOSED REASONS  
SUBMITTED BY ENVIRONMENTAL IMPROVEMENT DIVISION STAFF

This submission contains the findings of Environmental Improvement Division Water Pollution Control Section staff and consultants, and EID legal staff; it is organized as follows:

- A. RECOMMENDATION OF DISAPPROVAL AND GENERAL DISCUSSION OF REASONS
- B. CHARACTERISTICS OF THE SITE AND THE PROJECT
- C. DETAILS OF DEFICIENCIES OF THE DISCHARGE PLAN

EXHIBIT J

EQUAL OPPORTUNITY EMPLOYER

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A. RECOMMENDATION OF DISAPPROVAL AND GENERAL DISCUSSION OF REASONS

Before a discharge plan can be approved by the director, the person proposing to discharge must demonstrate that the requirements of the Water Quality Control Commission Regulations have been met. Of particular concern are the requirements of Section 3-109 pertaining to the criteria for director approval, and Section 3-107 pertaining to monitoring, reporting and other requirements. It is the opinion of EID staff that Bokum Resources Corporation has failed to demonstrate that the requirements of the regulations have been met. Therefore, it is recommended that this discharge plan be disapproved.

The applicant has chosen a site for uranium mill tailings disposal which is not isolated from either surface water or groundwater resources which are extremely vulnerable to contamination. The site selected is one which affords little or no natural protection of shallow ground water resources, and one in which, if contamination were to occur, cleanup might not be possible. In selecting this particularly difficult location, the applicant assumed a greater burden of responsibility to demonstrate that contamination will not result from the project than is generally assumed by other applicants. Similarly, many aspects of the project required more detailed examination by the staff than might otherwise be necessary if a site adequately isolated from surface and ground waters had been proposed.

To isolate the tailings retention area from natural disruptive forces, the company is dependent upon elaborate engineering solutions. Failure at any number of points in the engineered structures will, with virtual certainty, lead to violation of ground water standards at points of present or reasonably foreseeable future use. Therefore, our review has focused on the adequacy of the proposed engineering solutions for insuring that ground water contamination will not occur at points of present or reasonably foreseeable future use.

The staff feels that the discharge plan is deficient in a number of areas, but primarily it fails to demonstrate that engineering solutions will be adequate to insure that the regulations will not be violated. The following general discussion highlights the staff's reasons for recommendation of disapproval. Details of these points and citations to the discharge plan and transcript will be found in a subsequent section of this submission.

1. The applicant has proposed diverting high energy floodwaters from the Canon de Marquez drainage system by a dam and channel structure. A failure of the diversion channel could result in breach of the entire tailings retention basin. The processes which could lead to failure of the diversion channel which have not been adequately addressed include:
  - \*\* Aggradation reducing channel freeboard, leading to overtopping by flood flows and likely erosion of dam, primarily at the point of diversion.
  - \*\* Erosion of the diversion dam and channel sidewalls by piping and associated bank collapse.
2. The integrity of the tailings and diversion systems depends upon continued post-operational surveillance and maintenance. Inadequate provisions have been made by the applicant for such long term activities.

3. The applicant has failed to adequately consider the implications of the potential for chemical interaction between the acidic liquid tailings and the calcareous Mancos Shale and tailing dam materials. The interaction may cause reduction of tailing dam stability due to generation of high pressure gas and reduction in storage capacity of the tailing pond due to swelling of underlying clays and shales.
4. No details have been provided on tailings pond reclamation/stabilization procedures anticipated to be used. Specifically, no evidence has been submitted which demonstrates a reclamation design which will be capable of preventing the vertical migration of toxic and soluble salts from the tailings to the reclaimed land surface.
5. The monitoring wells located along the toe of the tailing dam for seepage detection are inadequately designed.
6. The applicant's treatment of seismicity and faulting is inadequate and should be strengthened. There is evidence that the applicant may have underestimated ground accelerations and shock factors associated with the maximum probable seismic activity at the site. Additional data is needed to document the presence or absence of faults in the tailings retention area. These data are needed to more effectively evaluate the long term stability of the diversion and tailings dams and the potential for pond bottom seepage to deeper bedrock units.
7. No documentation has been submitted discussing the possibility of the development of headward cutting arroyos westward toward the tailings pond.
8. No consideration has been given by the applicant to the water quality impacts related to the deposition of solid tailings along the Rio Salado by wind erosion and transportation.
9. No provisions have been made by the applicant for access for post-operational monitoring surveillance and maintenance of the tailings retention facility and diversion structure.
10. There are not adequate restrictions prohibiting water well drilling within the pond area after the land reverts to previous owners when operations are completed.
11. The contingency plan is excessively vague and addresses only potential contamination resulting from pond bottom seepage. No consideration has been given to contamination along Rio Salado resulting from transportation of tailings downstream by water or wind.
12. The evaporation pond appears to be sized only to hold the seepage from the tailings impoundments without provision for probable maximum precipitation events.

## B. CHARACTERISTICS OF THE SITE AND THE PROJECT.

The site selected for this project is one where ground water is particularly vulnerable to contamination. If tailings are distributed by whatever means along the Canon de Marquez, the Rio Salado and/or the Rio Puerco, they will become a continuing source of contamination, with ground water standards being exceeded at places of reasonably foreseeable future use. The distribution may occur by failure of any portion of the tailings dam or of the diversion system, or by wind. The elaborate engineering solution proposed by Bokum to prevent escape of the tailings contaminants has several features which have not been tried elsewhere and are not field proven (e.g. a surface water diversion of this magnitude; depending on natural cutting of part of the diversion channel). This makes conservative factors of safety even more important than they would be for field proven engineering solutions. Details and citations to the discharge plan and the hearing transcript follow:

### 1. Ground Water Vulnerability.

The shallow ground water resources in the Canon de Marquez-Rio Salado drainage are extremely vulnerable to contamination. The site selected for the proposed tailings retention facility is one which affords little or no natural protection of the shallow ground water. (See: Gallaher-transcript pp. 1613-1616.) The critical physical factors found at the site include the following:

- a. In some areas, only a few inches of unsaturated alluvium are present above the water table. Contaminants which are released from the tailings pond will enter the ground water system with little or no opportunity for attenuation resulting from interaction with the unsaturated materials. (See: Runnells-tr. pp. 1520; Gallaher tr. pp. 1613-1614.)
- b. Ground water and surface water along the Canon de Marquez-Salado Creek drainage system are intimately connected. That is, ground water in certain reaches of the creek is geologically forced to the surface, comingles with any surface water in the stream bottom, and subsequently re-infiltrates when the geologic constrictions are reduced. This phenomena allows for multiple points of immediate mixing between the ground water and contaminants distributed along the stream bottom or within a surface water body. (See: Tr. Runnells p. 1520, Billings pp. 87-88, Gallaher p. 1611 - et seq.)
- c. The sediments located along the Rio Salado are generally comprised of sand and gravels with limited amounts of interspersed clay material. The sediments are highly permeable and offer rapid percolation of contamination to the shallow ground water system. (See: Gallaher tr. pp. 1610-1613.)
- d. The amount of shallow ground water available for dilution of any introduced contamination is very limited. The system is fairly well confined and limited in lateral extent. (See: Gallaher tr. pp. 1609, 1615, 1616.)

### 2. Contamination Potential From Tailings.

Solid tailings which are distributed along Canon de Marquez-Rio Salado or Rio Puerco represent a long term source of contamination. Highly soluble toxic salts deposited on the surface of the particles are readily leached by precipitation or ground or surface waters. Subsequent to leaching, the salts are naturally redeposited on the particle surface and are available for further leaching or

dissolution. (See: Runnells tr. pp. 1503-1524, 1559.) In direct testimony Dr. Donald D. Runnells, EID Consultant, estimated that a release of 0.5% of the ultimate volume of tailings to be retained would result in ground water concentrations well in excess of many ground water standards. (See: Runnells tr. pp. 1521-1523.)

Bokum's expert witness on ground water agreed that if there were a failure of the tailings and/or diversion system resulting in distribution of tailings downstream, ground water contamination was possible. (See: Billings, cross by Runnells tr. pp. 284-285.)

If tailings were distributed along the Canon de Marquez and the Rio Salado, cleanup might be impossible as it was in a case studied by Dr. Runnells (See: Runnells cross by Garber tr. pp. 1569-1570.)

### 3. Forseeable future use.

The potential for reasonably forseeable future use of the local ground water along the Canon de Marquez-Rio Salado drainage system is significant. Most notable to the future use consideration is the following:

- a. Historical and recent withdrawals for potable and stock uses have occurred at Evans Ranch (See: Ramon Gonzales' statement, tr. pp. 1617-1618), located approximately 1 and 1/4 miles down hydraulic gradient from the pond site, and on Laguna Indian land near the confluence of the Rio Salado and Rio Puerco there is present use as well. (See: Cheromiah tr. pp. 415-420, Correa, tr. pp. 437-444).
- b. Domestic withdrawals are projected to soon occur at Majors Ranch, Laguna Indian property, located approximately 7 miles down hydraulic gradient from the pond site. (See: Correa tr. pp. 442-443, 476-480.)
- c. Additional local withdrawals may result from the probable economic and population growth of Marquez Village. (See: McBride testimony, tr. pp. 1123-1124.)
- d. The shallow ground water system along the Canon de Marquez drainage is principally recharged by downward percolation of seasonal surface water flows and generally perennial spring discharges. This reliable source of ground water recharge results in a dependable supply of accessible water. The installation of a shallow well or infiltration gallery along the Rio Salado could provide a dependable supply of water for potable, stock, or irrigation uses. (See: Gallaher tr. pp. 1616, 1619-1622 and Billings tr. p.295 testimony),

### 4. Unusual Features of this Project.

One feature of this project which has not been tried elsewhere and field proven is a surface water diversion of this magnitude around a tailings pile, and which is expected to last in perpetuity with minimal or no maintenance. Dr. Billings has stated that he knows of no such diversion (Billings, cross by Burnett tr. pp. 136-137, 152-153). Dr. Simons also says that this sort of plan is a precedent in his experience and "we are going to a higher level of engineering design". (Tr. pp. 954 and 1047-1048.) Mr. Crout introduced an

excerpt from "Surface Tailings Disposal for the Minerals Exploration Co., Sweetwater Mine and Mill Project, Sweetwater County, Wyoming" as a comparable example (Tr. pp. 1323-1330) but on close examination the situation of the Sweetwater Project proved to be completely different from Bokum's Marquez Project. (Bivins, Supplementary Testimony submitted as part of EID submittal package of May 24, 1979.)

Another unique feature of this project is the proposal to have part of the diversion channel cut by natural erosion rather than by mechanical construction. Dr. Schumm, the designer of this system, admitted that he had no previous experience in the design of such a system and he does not know how fast the cutting may take place. (Schumm, cross by Garber tr. pp. 1159-1161.)

A plan that contains new experimental features which have not been proven in the field must have conservative factors of safety in the engineering design in case real world events do not exactly follow theoretical predictions.

5. Safety Factor Provided by Probably Maximum Flood Calculation.

There is general agreement between the EID staff and Bokum consultants as to the magnitude of the probable maximum flood (PMF) which should be designed for (See: Bivins testimony, tr. pp. 1308-1310). However, there is disagreement as to the factor of safety provided in designing for this pmf. The design flood of 35,500 cubic feet per second is the minimum acceptable to the EID staff. (See: Lagasee testimony, pp. 1433-1435; Bivins testimony pp. 1310-1311.) We cannot agree with the suggestion repeatedly made by the Company that this design flood is over-conservative and results in a design having a large margin of safety. (See: Simons tr. pp. 918 - 919.) A review of the hearing transcript will show that the hydraulic calculations employed in sizing the diversion ditch are very sensitive to the "engineering judgment" and assumptions used therein. (See: Cross of Simons by Lagasee; p. 919; Lagasse direct p. 1404.) Slight changes in the input assumptions can greatly reduce the margin of safety as calculated. The calculations presented within the discharge plan must be viewed as only rough approximations of the natural system. (Lagasse, Comment on Rebuttal Testimony by Bokum Consultants, dated May 21, 1979, part of EID submittal package of May 24, 1979, page 3).

6. Safety Factor Provided by Increased Sizing of Protective Riprap.

With the submission of May 24, 1979, Bokum increased the median diameter of the riprap along the initial 800 feet of the channel from 24 inches to 36 inches. The staff feels that the revised sizing of the rock material satisfies our major objections that the 24 inch diameter would be inadequate to withstand the anticipated hydraulic shear stresses at the point of diversion of Canon de Marquez.

However, we cannot support the statement that the increase in size of riprap "will provide a very large factor of safety against major floods including the PMF for the foreseeable future". (Statement by D.B. Simons in Bokum submittal of May 24, 1979.) No calculations are provided to support this statement. We feel that the 3 feet median diameter stone size is the minimum acceptable for design purposes, and provides no extra margin of safety. Dr. Lagasse's calculations indicated that the 2 foot diameter first proposed was definitely too small. (Lagasee, tr. pp. 1416-1418.)

C. DETAILS OF DEFICIENCIES OF THE DISCHARGE PLAN.

Details of points enumerated in Section A of this submission, together with citations from the discharge plan and the material of the public hearing record follow. The numbering system of Section C is the same as Section A-- explanation and citations for a particular number in Section A can be found under the same number in Section C.

1. THE DIVERSION SYSTEM.

The applicant proposes to divert floodwaters from the Canon de Marquez drainage system into the Canon de Santa Rosa. The diversion system must be able to transport high velocity flows, up to approximately 30 feet per second, and all sediment which is transported within the arroyo systems intercepted by the diversion channel. (See: Memorandum from Daryl B. Simons to Edmund J. Schneider, dated February 24, 1979, Exhibit EID 4U). A failure of the diversion channel to hydraulically and structurally withstand such demands could result in encroachment and possible breach of the entire tailings retention basin. To assess the long term adequacy of the proposed system, it is necessary to evaluate in detail the hydraulic characteristics, hydraulic performance and stability of the system, and geomorphic variables in a dynamic state.

Dr. D.B. Simons in the aforementioned memorandum, describes the aggradation phenomena which is to be expected in the channel: "The relatively large bed load material and the variation in the sediment transporting capacity of each element of the system will induce local aggradation and degradation until the system adjusts to a new equilibrium." We believe that Bokum consultant's quantitative analysis of the amount of sand size sediments to be expected at the point of diversion and in the diversion channel provide a rough estimate of aggradation quantities for the assumed conditions of flow. (See: Lagasse direct, tr. pp. 1406-1407.) However, because the required height of dam to convey the design Probably Maximum Flood is so sensitive to the amount of aggradation, we do not feel that the calculated values are adequate. Specifically, the limitations in the calculations are:

- a. The calculated quantities represent sedimentation only at a single point in time. The calculational technique used does not assess the cumulative aggradation over a long period of time resulting from multiple runoff events. (See: Simons cross by Garber, tr. p.1821.)
- b. Within what we consider to be reasonable engineering judgement, the aggradation estimates developed by the technique could vary by as much as a factor of 2 or more. Additionally, engineers are fortunate to estimate sediment transport rates within 40% of the actual situation. (See: Lagasse direct, tr. p. 1404.)
- c. The calculations are based upon the ability of the channel to divert and transport sediment with a median diameter of 0.2 millimeters. We are not convinced that the coarse material moving through the system has been adequately represented in this median grain size number. (See: Lagasse direct testimony, tr. pp. 1395-1399, 1406.)

- d. The calculations only consider the hydraulics and sediment characteristics of Canon de Marquez. No quantitative evaluation has been made of the water and sediment contribution from Arroyo Hondo, unnamed arroyo, or from Mesa Canoncito once the channel incises to a new baselevel. (See: Simons, direct tr. pp. 867, 870-873, Schumm cross by Lazarus, pp. 1244-1246.)

Given the uncertainties in the above calculations and their inherent limitations to duplicate the dynamic natural system, we seriously question the following recent suggestion made by Bokum consultants: "The analysis also verifies that aggradation will not be a problem in the diversion channel when operating on the final gradient of about 1.8%." (See: Memorandum from D.B. Simons et al., to Edmund J. Schneider, dated May 16, 1979; part of Bokum May 24, 1979, submittal.)

Slope is the most significant stream channel parameter controlling whether aggradation/sedimentation will occur or not at the point of diversion of Canon de Marquez. Generally, if a change in slope does not occur through a given reach of channel, there will not be a net gain or loss of sediment being transported through various segments of that reach. (See: Schumm's analysis in the March addendum of Bokum Resources Corp.) A reduction in slope downstream will induce a net build up of sediment at the point of slope reduction relative to a upstream segment. An accurate determination of the effective slope of Canon de Marquez at the point of diversion is critical to evaluating whether aggradation will occur in the diversion channel after the final channel design slope of 1.8% is achieved.

The applicant maintains that once the final channel slope is attained, there will not be a break in slope from the Canon de Marquez at the point of diversion. It is further argued by the applicant that because there will not be a break in slope no net aggradation will occur at the point of diversion and, consequently, eliminate the need for long term maintenance or removal of accumulated sediment. (See: Simons memo, May 24, 1979 submittal.) Indeed, the assumption which the applicant utilized in all arguments and calculations is that the effective slope of Canon de Marquez near the point of diversion is 1.8%.

A major deficiency in the discharge plan is the lack of documentation clearly illustrating at which segment of the Canon de Marquez did the applicant measure the 1.8% slope. In fact, one Woodward-Clyde report and also the discharge plan put the slope at 4.8% and several other slopes are also given. (Cross of Holliday by Lagasse Tr. pp. 713-719.) The only evidence or descriptions presented by the applicant which addresses at what segment the 1.8% slope was measured is a verbal description by Dr. Schumm (See Schumm testimony on cross by Wells, Tr. page 1193). The staff cannot independently verify the validity of this very critical measurement without additional detailed descriptors.



It is important to note, given the proposed channel configuration, a 1.8% slope cannot be exceeded. (See: Holliday cross by Lagasse, Tr. pp. 719-723). This is particularly relevant considering the following:

- a. If the effective slope of the Canon de Marquez is greater than 1.8%, then net aggradation will, in all probability, take place at the point of diversion,
- b. If an increase in slope occurs, for whatever reason, along Canon de Marquez, the diversion channel will be unable to geomorphically respond with an according increase in slope beyond the 1.8%.

Regardless of the degree of channel stability along Canon de Marquez, man's local activities may produce major changes in system characteristics both locally and throughout the entire stream reach. (See: EID Exhibit 4-0). An increase in sediment load from present and foreseeable activities such as mineral exploration drilling and mine development, or from removal of vegetation cover by forest fire will induce geomorphic changes to the Canon de Marquez. (See: Simons cross by Bivins, pp. 907-911). If the stream responds to the increase in sediment with a steepening in slope, we are not convinced that the diversion channel will react as predicted by the applicant.

The staff does not feel that the applicant has shown the ability of the diversion channel to respond to a change in geomorphic variables, e.g. an increase in sediment load, given the slope limitations of the diversion channel.

The applicant has not precisely determined the quantities of aggrading sediment in the diversion channel. Without continued maintenance and removal of any accumulated sediments and debris from the channel bottom, the possibility remains that aggradation may occur and result in the loss of channel design capacity. If the diversion system is overtopped, erosion of downstream wall of the diversion dam is also likely (See: Holliday cross by Watt, Tr. p. 660).

After review of the transcript and recent company submittals, we are not convinced that the applicant has given adequate attention to the role of piping as a potential failure mechanism of the (See: Schumm cross by Wells, Tr. pp. 1173-1243), diversion ditch. Dr. Schumm, Bokum's geomorphologic consultant, recognizes piping as an important exciting and common process in arroyo formation and that piping does occur in the proposed tailings area. (memorandum from S.A. Schumm to R.R. Waggoner; part of bokum submittal of May 24, 1979). Dr. Schumm states "If it (piping) does occur, it is subordinate to the other processes of erosion such as surficial creep, rainwash and raindrop splash". No data or justification, however, was supplied for this statement.

Instability caused by piping and associated bank failure could adversely affect the long term stability of the diversion ditch bank.

## 2. POST-OPERATIONAL SURVEILLANCE AND MAINTENANCE

The integrity of the tailings and diversion systems depends upon continued post-operational surveillance and maintenance. Inadequate provisions have been made by the applicant for such long term activities.

An applicant witness, Dr. Simons testified, "I just have a very very difficult time indicating that I have the competence to design something that would never require any more maintenance, if you are talking about foreseeable future time, such as has been indicated here." (Tr. 912.) He also testified that after Bokum has left the site, periodic inspection and possible maintenance would be necessary, and that it was prudent to inspect the diversion channel each 5 years and after each major flood event for at least 100 years. (Tr. 960 and 961.) Dr. Schumm, another Bokum witness, under cross examination by Mr. Burnett stated that he agreed with Dr. Simon's recommendation of inspection every 5 years. (Tr. 1252 and 1253.) Under questioning by the hearing officer, Dr. Simons said that he thought additional regulation and assurance there would be post-operational follow through would be needed. (Tr. 1049 through 1051.)

When Dr. Simons suggested larger riprap he said this would reduce the need for post-operational surveillance and maintenance (Simons, Bokum submittal of May 24, 1979). But Mr. Bivins pointed out that riprap size was not the only consideration in the need for maintenance and quoted another Bokum consultant's comments about the maintenance needed for removing weeds, trash and silt. (Bivins, EID submittal of May 24, 1979).

Nowhere in the discharge plan has the company made any commitment which will insure that such inspections and the necessary maintenance will be carried out during the reasonably foreseeable future. (100 to at least 200 years.) The applicant attempts to avoid its responsibility to demonstrate to the Director that there will be adequate surveillance and maintenance to assure that ground water will not be contaminated at a place of withdrawal for present or reasonably foreseeable future use. Instead of eliminating the need for post-operational maintenance and repair, the applicant attempts to place the burden on the Radiation Protection Act's continued care fund. (Dr. Simons, Tr. 1063.) Applicant's reading of the continued care fund provisions is incorrect. The continued care fund is not intended to pay for future expenses which could have been avoided by the discharger or to relieve a discharger of its responsibility to comply with applicable regulations. (Garber, EID submittal of May 24, 1979.) The discharge plan therefore is deficient in that it does not specify a surveillance and maintenance program or commit to carry out that program or establish, by any means, an assurance that the continued care recommended by its witnesses will be carried out.

### 3. REACTION BETWEEN ACID RAFFINATE SOLUTION AND SHALE

The possibility that the acid raffinate solution might react with the limestone in the Mancos Shale with a resulting production of carbon dioxide gas, at theroretically high pressures, was raised by Dr. Runnells during the public hearing. (See: Cross of Billings by Runnells, Tr. page 5285-288; cross of Holliday by Runnells 692-696 Tr. page 1500-1502; direct by Runnells Tr. page 1500-1502). The consultants for the applicant apparently remain unimpressed by the possibility or its implications. We must note the presence of 15 to 25% limestone in the Mancos Shale (Table II, Woodward-Clyde Consultants submittal dated May 15, 1979; part of May 24, 1979 submittal by Bokum). The staff is not convinced that the applicant has demonstrated an awareness of potential problems associated with putting an acid waste into a pond built on a calcareous rock. A misinterpretation of the theoretically high pressures which could be generated may result in a structurally weakened tailing dam.

As discussed by Dr. Billings and Dr. Runnells, a significant reaction may occur when acidic solutions come in contact with the weathered Mancos shale. (See: Cross of Billings by Runnells, Tr. page 285-288; direct testimony of Runnells, Tr. page 1500-1502). Specifically, the reaction may result in swelling of the clays or gaseous puffing of the weathered shale (Runnells direct, page 1502). A uniform swelling of the entire thickness of clays and weathered shale poses the possibility of loss of storage capacity in the pond. Of particular concern is if the storage capacity is diminished by such processes, will the applicant increase the height of the dam? If so, how will this affect other factors in the design, such as the positioning of the cut-off trench and diversion ditch? We believe that additional laboratory tests should be performed to determine the response of the substrates to the raffinate waste. (See: Laboratory test recommendations by Runnells, direct testimony, Tr. page 1502).

### 4. RECLAMATION AND STABILIZATION PROCEDURES

It is, of course, important to isolate the tailings from natural disruption after cessation of operations as well as during operations. Key to stabilization of the surface of the tailings pond is a well designed reclamation program. No details have been provided on the tailings pond reclamation/stabilization procedures anticipated to be used upon cessation of milling operations.

As discussed in the hearing by Dr. Runnells, a successful reclamation operation must consider the potential for vertical capillary movement of the soluble tailings salts into and through the soil reclamation cover. If the salts were to migrate to the surface of the reclamation cover, they would be readily available for transport. (See: Runnells direct, Tr. page 1524-1526). In essence, if the reclamation techniques could not adequately disrupt the capillary movement of the salts, a perpetual supply of highly soluble contaminants could be available for distribution downstream. The importance of the reclamation design is greatly enhanced due to the requirement that the applicant must install a spillway structure into the tailing dam (Bokum Exhibit #12). (See: Cross of Holliday by Burnett, Tr. pp. 540-546). Any contaminants leached by rainfall from the pond surface would be encouraged to exit the tailings basin.

Considering the lack of historical success in stabilization of tailings pond and the vulnerability of the site, the staff believes that the lack of reclamation details in the plan is a major deficiency. (See: Runnells cross by Robinson, Tr. page 1544-1545).

5. DESIGN OF MONITORING WELLS LOCATED ALONG THE TOE OF THE TAILING DAM

The deficiencies in the design of the seepage detection wells located along the toe of the tailing dam were discussed during the public hearing. Dr. Billings agreed in principal with Division concerns that the proposed well design was not optimum and probably needed to be structurally modified. (See: Cross of Billings by Gallaher, Tr. page 312-313).

We believe that the wells are unacceptable for reliable detection of seepage and should be redesigned or modified. (See: Design modification recommendations by Gallaher, direct testimony, Tr. page 1605-1607).

6. SEISMIC AND FAULTING POTENTIAL OF THE SITE

The staff feels that the applicant's treatment of seismicity and faulting is inadequate and should be strengthened. As discussed by McQuillan, (See: May 24, 1979 EID submittal) Bokum consultants may have underestimated ground accelerations and shock factors associated with the maximum probable seismic activity at the site. In fact, there is evidence that the company calculated maximum probable seismic intensity could have been experienced at the project site only 61 years ago. Unfortunately, company consultants familiar with the calculations were not available for cross examination during the hearing. (See: Cross examination of Frank Holliday by Dennis McQuillan, Tr. pages 775-777). We cannot verify the reported intensities with the information available. Considering the sensitivity of the proposed site vicinity to contamination, we regard this a deficiency in the discharge plan. A miscalculation of the possible intensities at the site could effect the structural stability diversion dam as well as the tailing dam.

It is assumed numerous faults are present beneath the alluvium in the Rio Puerco Fault zone (See: Lazarus, May 24, 1979 EID submittal). Additional data is needed to document the presence or absence of faults in the tailings retention area. (See: Memorandum from Bruce Gallaher and John Dudley to Maxime Goad, dated Oct. 25, 1978, EID Exhibit 4-G). In all likelihood, a three dimensional cross sectional geological diagram constructed from exploratory drilling records would be sufficient information to support or refute the absence of a major buried fault in the pond area. An accurate evaluation of pond bottom seepage potential or of dam stability cannot be reliably made without this kind of information. (See: Cross of Sean Muller by Jay Lazarus, and Correa by Garber, Tr. pages 452-454).

Virtually no deep subsurface information has been supplied which could be used to examine faulting characteristics in the vicinity of the diversion dam.

7. HEADWARD MIGRATION OF GULLIES NEAR THE TAILINGS DAM

As agreed upon by Bokum consultants, there are headward migrating discontinuous gullies east of the tailings dam (cross of Schumm by Wells Tr. pp. 1237-1242). Discontinuous gullies in alluvium are unstable geomorphologic features (cross of Schumm by Wells Tr. pp. 1237-1242). If the gullies were to continue their headward migration to the west, their subsequent encroachment on the tailings dam could jeopardize the tailings dam structure. The applicant maintains that this will not occur because the dam will effectively disrupt water sources which are contributing to erosion at the head of gullies. However, we feel that this may only reduce the rate of headward migration. The applicant has not submitted any documentation which could enable us to project rates of headward migration in the vicinity of the tailings dam. With a lack of convincing data, we must assume the subsequent encroachment of the gullies could be a legitimate failure mechanism of the tailings dam.

8. WIND BLOWING OF TAILINGS

Relocation of solid tailings by wind transport is a possible cause of ground water contamination downstream. (See: Billings cross by Runnells Tr. pp. 283-284; Runnells direct testimony Tr. p. 1514 et seq; Runnells cross by Robinson, Tr. pp. 1539-1540.) No consideration has been given to the water quality impacts related to deposition of solid tailings along the Rio Salado by wind during or after operation of the tailings pond.

9. POST-OPERATIONAL ACCESS

No provisions have been made by the applicant for access for post-operational monitoring, surveillance and maintenance of the tailings retention facility and diversion structure.

Access to the premises of the tailings retention area will be necessary both for the continuing surveillance and maintenance of the diversion structure and for post-operational monitoring of the tailings retention facility and monitoring wells. There is extensive testimony on the record which demonstrates that the applicant does not have permanent right of access to the area. The land upon which the bulk of the tailings will be placed reverts to the Juan Tafoya land grant after the applicant completes its' Uranium milling operations. (Tr. 1092). At that time in order to gain access the State or other responsible regulatory entity would be required to obtain access rights from the land grant. The regulatory body would have to follow condemnation procedures and pay the land grant for these access rights. Testimony of Robert McBride (Tr. 1107).

The applicant has therefore failed to provide a necessary part of the discharge plan, access for post-operational monitoring, surveillance and maintenance in the plan, and has again attempted to shift its responsibility for ground water protection to the state.

10. POST-OPERATIONAL DRILLING IN THE TAILINGS POND AREA

There are not adequate restrictions prohibiting well water drilling within the pond area after the land reverts to previous owners when operations are completed. As stated in point 9 above, the applicant does not have rights to the lease property after cessation of operations. Although there is a restrictive covenant in Bokum Supplemental Submission Appendix F, February 5, 1979, (EID Exhibit 1-C), the applicant will not have any right to be on the land and, will have no interest in the covenant or inclination to enforce it. It will be extremely difficult for the State to enforce such a covenant unless regular inspections of the premises are made at relatively short intervals to insure that no wells are drilled into the tailings retention area. This would incur another cost upon the State and would entail yet another of the applicant's responsibilities which it attempts to transfer to the State.

An additional problem occurs in that the restrictive covenant does not cover the "El Bosque" tract (BRC map of the tailings disposal site, EID Exhibit 1-C) which is also, in part, underneath the tailings area. The owners of that tract could remove the water within the pond area at will in the reasonably foreseeable future.

The applicant has not satisfied the burden of showing that the water under the tailings pond, which throughout the transcript was described as highly polluted, will not be used in the reasonable foreseeable future. All that has been provided is a restrictive covenant which will be extremely difficult to enforce and only covers part of the tailings area.

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11. CONTINGENCY PLAN

The contingency plan is excessively vague and addresses only potential contamination resulting from pond bottom seepage. No consideration has been given to contamination along the Rio Salado resulting from transportation of tailings downstream by water or wind.

The contingency plan states the applicant "will contain any seepage contamination on their leased acreage of the Juan Tafoya land grant, by means of seepage collection ditches or wells, grouting of seepage zones, or pond lining." (P. 56, EID Exhibit 1-C.) The testimony of Dr. Billings, a witness for the applicant, in conjunction with the Contingency Plan itself, demonstrates that the plan lacks specificity, is incomplete, does not address period post-operational contingencies and may be entirely inadequate to control seepage which does not reach the monitoring wells prior to cessation of operations. (Tr. 246-261.)

The second part of the contingency plan is also deficient. It only provides for protection of water within the lease property. It does not provide for containment of contamination but only an alternate source of water supply for those using the contaminated aquifer (this would not prevent the aquifer from becoming contaminated beyond the property which Bokum has leased). It does not adequately specify the method of construction of wells which will be used in the alternate source and the possibility of seepage of polluted waters to other aquifers. The time limit of the commitment to replace polluted water supplies with deeper wells is not stated. (Testimony Tr. 246 through 261.)

In summary the contingency plan is vague, incomplete and unacceptable as it relates to seepage from the tailings retention area. This plan will be impossible to rely on in the future for a clear understanding of the applicant's commitments and enforcement purposes. In addition the contingency plan is entirely deficient in that it does mention or provide for the possibility of the escape of tailings from the retention area downstream along the Rio Salado (Billings, Tr. 158-159; Runnells, Tr. 15-24.)

12. SEEPAGE EVAPORATION POND

The evaporation pond appears to be sized only on the amount of seepage water which is collected by the tailing dam chimney drain and conveyed by the seepage collection ditch. The applicant was unable to produce documentation during the hearing that showed the pond capable of storing all the water associated with a Probable Maximum Precipitation event. (See: Holliday cross by Bivins, Tr. pp. 702-704, 711-712.)



Notwithstanding the above legal and technical deficiencies of the discharge plan, the staff feels obligated to highlight the following for the Director's consideration. The proposal to divert surface water around the tailings disposal area from a drainage basin of this size (greater than 10 square miles) appears to be without comparable precedent. In addition, there exist rather severe limitations in the current state-of-the-art for predicting how an artificial diversion channel will evolve and respond to varying natural flow events through time. Furthermore, it has been pointed out that the predictive techniques which have been employed to date by Bokum consultants for estimating amounts of aggradation in the diversion channel are not the most sophisticated or complete currently available and that considerably more precision in these estimates could be achieved by utilizing more refined techniques currently available. It should be emphasized however, that even if the most advanced predictive techniques are employed there will remain considerable uncertainty in the computed results.

A question which is clearly before the Director and must be addressed at some point is: How much uncertainty regarding possible failure of the diversion system is acceptable within the framework of the regulations? The technical staff would offer the following to assist the Director in making this very important decision.

Uncertainty is something that anyone working with ground water deals with on a daily basis. Ground water hydrology, hydrogeology and geochemistry are all "imperfect sciences." In reviewing discharge plans, there are always varying degrees of uncertainty inherent in answering questions like: Will this discharge at point A cause ground water standards to be exceeded at point B? This sort of question can rarely be answered yes or no with complete certainty.

In such cases it is quite normal or routine for the staff and the applicant to perform calculations which evaluate so-called "worst case" conditions regarding the discharge and/or the hydrogeologic and geochemical characteristics of the site.

While there may be uncertainties associated with any individual calculation or analysis, an acceptable level of certainty is ultimately achieved by thorough examination of failure mechanisms, consequences (including time lags) and other processes which may reasonably be judged effective in mitigating adverse impacts. If, however, significant uncertainties still exist after such analysis then additional data may be required or it may be appropriate to address the matter through contingency planning or other modification of the plan.

Testimony presented by Dr. Runnells indicates that a relatively small (a fraction of 1% of the total projected volume) loss of solid tailings down Salado Creek by water or wind erosion will, with virtual certainty lead to a violation of all the numerical standards in the ground water regulations. This gives one a very vivid appreciation for just how vulnerable the site is. The question before the Division becomes: How certain are we that such losses of tailings solids down Salado Creek will not occur during the time before or after Bokum abandons the site?

The plan places complete reliance on engineered containment and diversion structures to prevent the loss of tailings solids from the disposal area. Failure in any one of these structures may lead to immediate or eventual release of tailings solids to the Salado Creek drainage. If such an event were to occur the impacts would be felt instantly with no opportunity for effective remedial measures.

The staff feels that the presence of a major diversion works directly above the tailing disposal is particularly inappropriate and dangerous in this case where shallow ground water resources are so vulnerable. Such a diversion constitutes a threat to the integrity of the tailing disposal area in perpetuity.

Consequently, staff feels that as long as such a major diversion of Canon de Marquez around the tailings area with its inherent risks and uncertainties is part of Bokum's proposal to the Division, the plan should be disapproved.